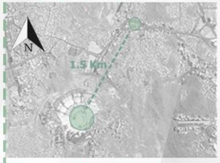
SUSTAINABLE DESIGN II
(MASTER)
REDESIGNING FOR HOTEL MAKKAH

by / Eng : Abdulaziz Aldelaiwi

Supervision
Prof.Khaled Samy
Prof.Ehab Rached

Project Info

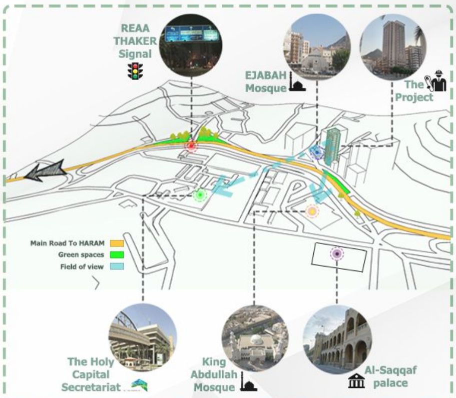
The project is located in Makkah Al Mukarramah in Al Maabdah district
On the land area: 434.10 m2
The built-up area: 4501 square meters
Number of floors: 13 floors
Number of parking spaces: 16
It is located on two façades: south-west and north-west
It is 1.5 km from the HARAM
Carrying capacity : 1607 Person

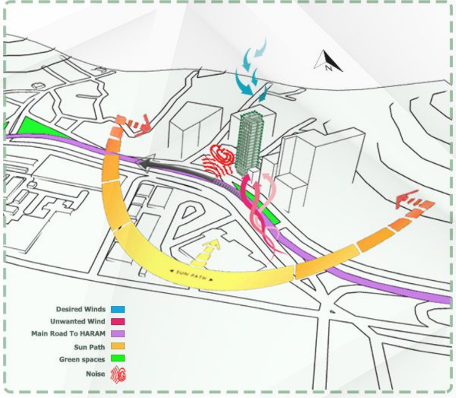


The project is about 1.5 from HARAM

The project is located in Al-Maabdah neighborhood

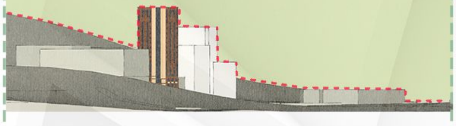
Site Analysis



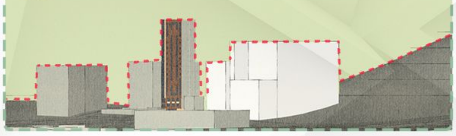


Sky Line

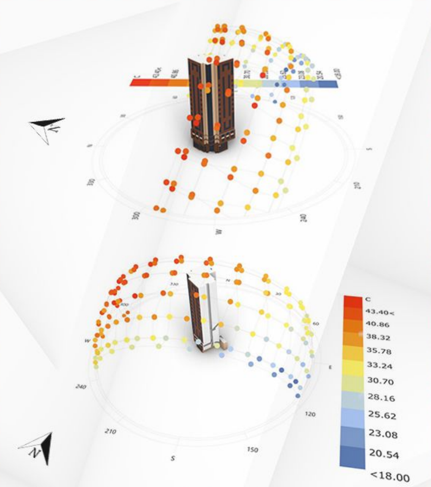
The sky line with the surroundings, be it buildings or mountains from the western side.



The sky line with the surroundings, be it buildings or mountains from the southern side.



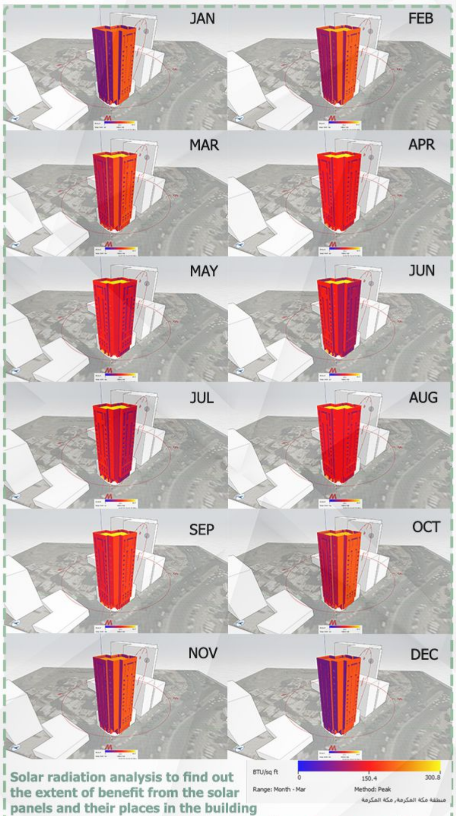
Sun Path



The angles and movement of the sun during the seasons, as it becomes clear to us that the highest angle of the sun on the building is in the summer and the lowest angle of the sun is in the winter.

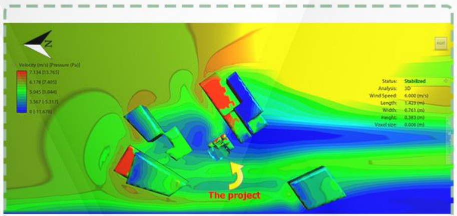
Project Photos

Solar Radiation

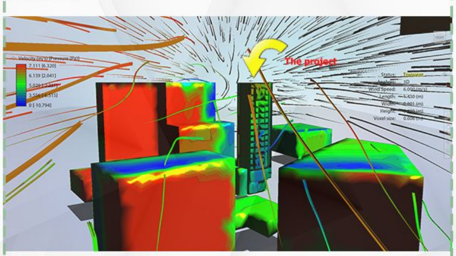


Solar radiation analysis to find out the extent of benefit from the solar panels and their places in the building modification stage , Plus find out the places most exposed to solar radiation, thus taking into account their shading, which reduces the electrical effort in cooling and saving energy.

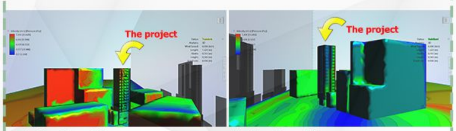
Wind Analysis



General Site



The Northern Side

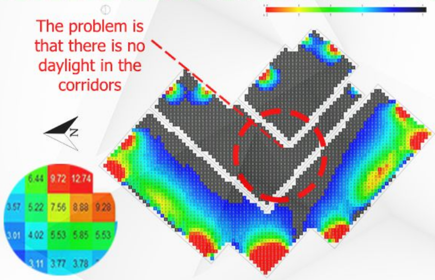


The Northern Side

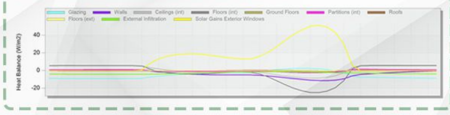
The Southern Side

Wind direction and the impact of neighboring buildings on its movement , Knowing that the winds in this region do not exceed 4,2 m / s throughout the year, which excludes the use of electric power generators through wind turbines.
And it is clear to us, as in the pictures, that the highest point of wind pressure on the building is in red.

Daylight

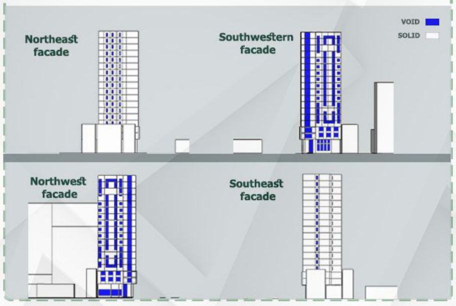


We notice that daylight does not reach the corridors or internal spaces sufficiently, which calls for their lighting during the day and thus an additional load on electrical energy.
As it can be seen in the picture below, the building is heated through the windows in a very large way.



Solid And Void

It is clear to us that the open rate is almost 50 per cent, which helps in the waste of electricity and cooling , as this must be addressed in the redesign.



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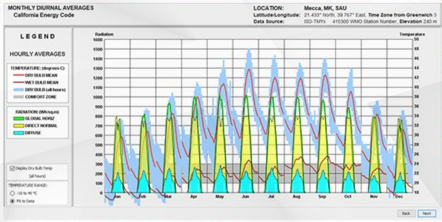
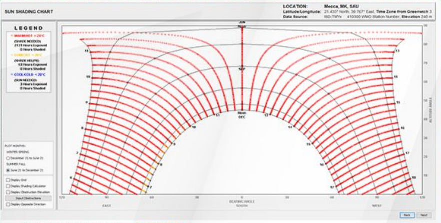
Climatic Studies



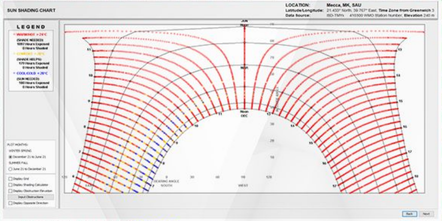
-Dry Heat And Rates Of Solar Radiation

We find by analyzing the chart in the figure that in the following months (**December, January, February**) that the dry temperatures are **close** to the **thermal comfort zone** (considering that thermal comfort is according to Ashry Standard 55, which defines thermal comfort between dry temperatures of 20 to 24 degrees)
As we note the rates of solar radiation are generally high.



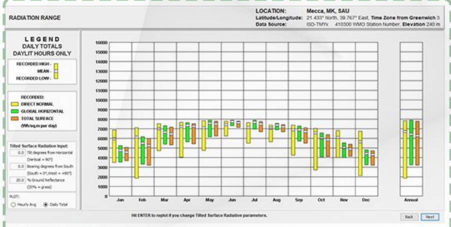
-Shading Rates in Summer

The number of hours we need shadows = **2131 hours**
Number of hours in which solar radiation is auxiliary to thermal comfort = **53 hours**
The number of hours that we need solar radiation = **3 hours.**



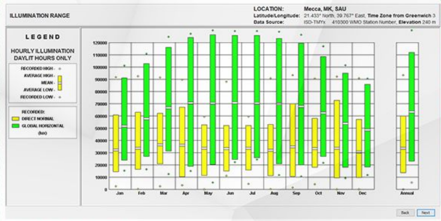
-Shading Rates in Winter

The number of hours we need shadows = **1897 hours**
Number of hours in which solar radiation is an aid to thermal comfort = **179 hours**
The number of hours that we need solar radiation = **100 hours.**



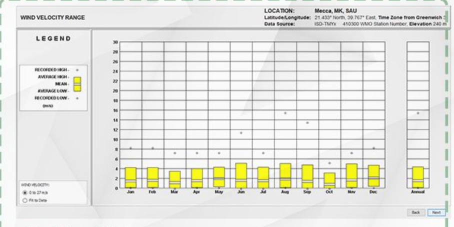
-Solar Radiation Rates

We note that the highest solar radiation is in the months of **December and February**
And the least solar radiation is in the month of **June.**



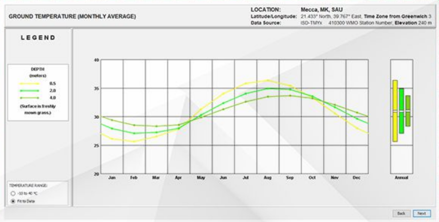
-Solar Lighting Rates

The average solar illumination is high in **November**, which is the highest, at about **72,000 lux**
The lowest amount in **June and July** is **52,000 lux .**



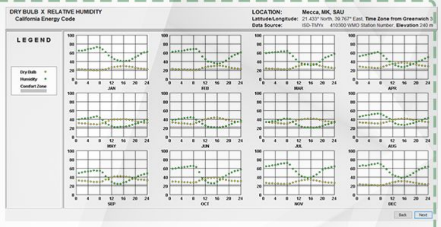
-Wind Speed Rates

The wind speed usually does not exceed **6 m/s**, which excludes the use of wind turbines for power generation.



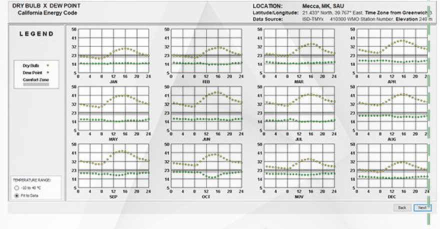
-Earth's Temperature Rates

The highest global temperature is in **August**
The lowest temperature of the earth is in the month of **February.**



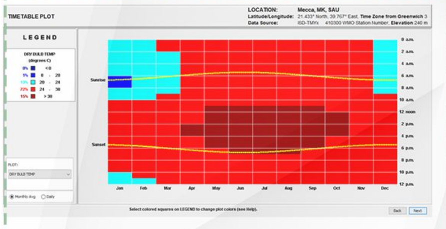
-Humidity Rates

We notice an **increase** in humidity levels in **January** and **December** by about **75%.**



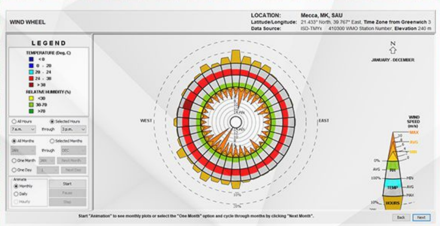
-Dew Rates

We observe dew rates between **15%** and **20%** throughout the periods of the year.



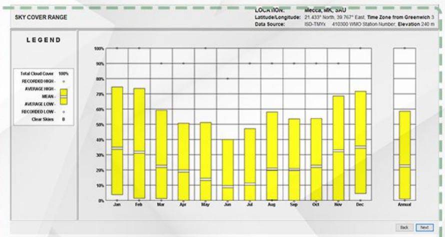
-Temperature Rates

The highest temperatures are between **April** and **October**, at **15%** of the year's average, by **above 38** degrees Celsius
The lowest temperature is in **January**, at **1%** of the year's average, by less than **20 degrees** Celsius.



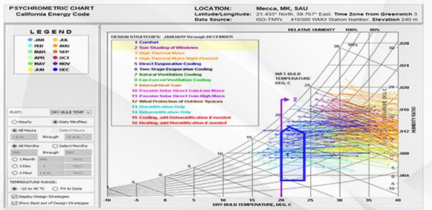
-Wind Rose

We notice that most of the winds are north and southwest.



-Sky Line Rates And Coverage

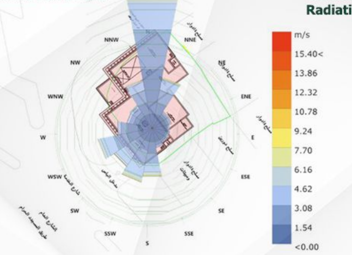
In the following months, the sky will be **January, February, November, and December**, the lowest incidence of solar radiation, with a screening rate of approximately **75%.**



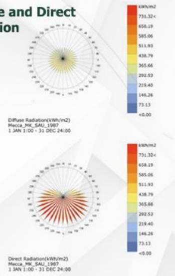
-Psychrometric Chart

Through these studies, we will show many design strategies that will come next.

-Wind Movement

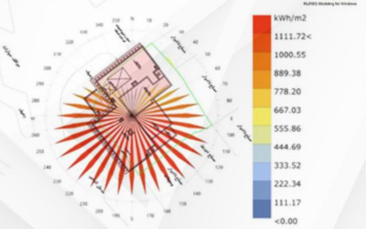


-Diffuse and Direct Radiation



-Total Radiation of sun

Total Radiation(kWh/m2)
Mecca_MK_SAU_1987
1 JAN 1:00 - 31 DEC 24:00



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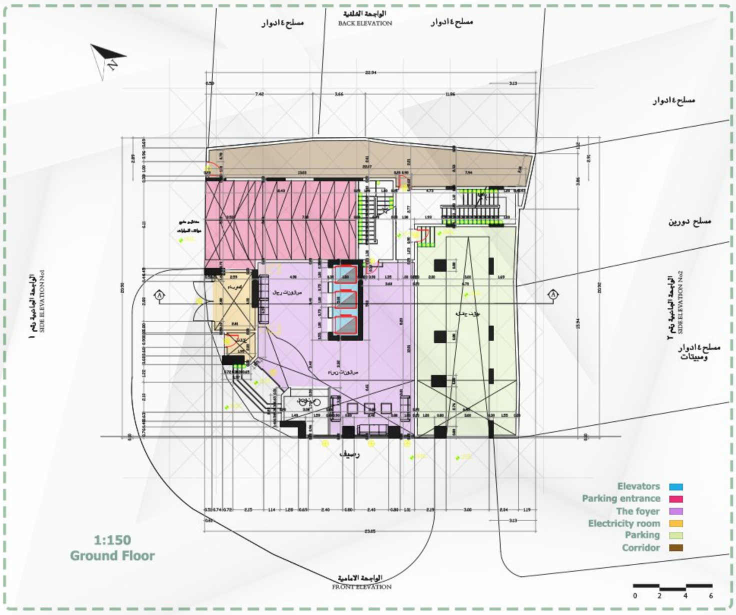
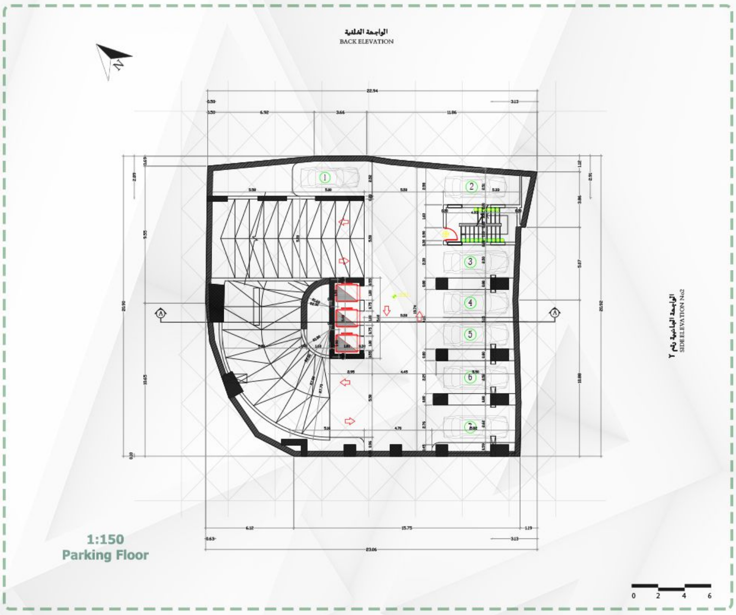
Plans of Current Situation

The current situation of the building that requires redesign to improve its energy consumption performance and make it more sustainable .

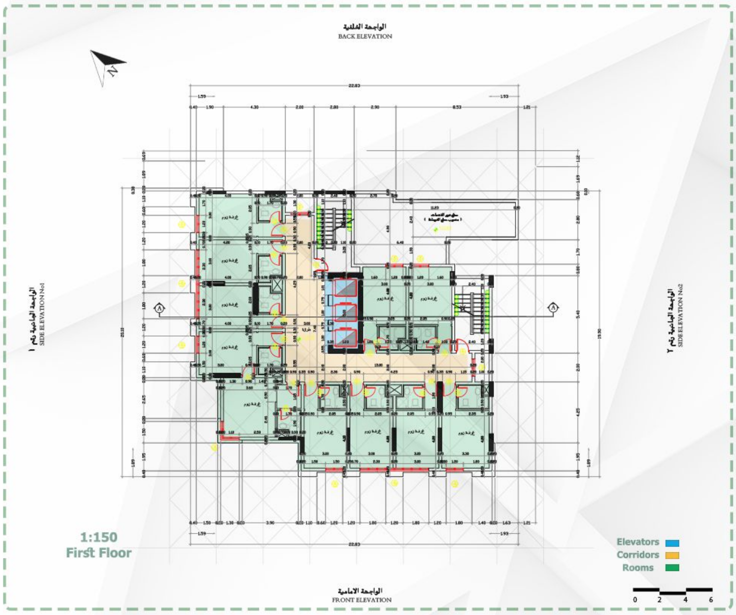


Elevators 🟦
Parking entrance 🟥
The foyer 🟪
Electricity room 🟧
Parking 🟩
Corridor 🟫

1:150
Ground Floor



1:150
Parking Floor

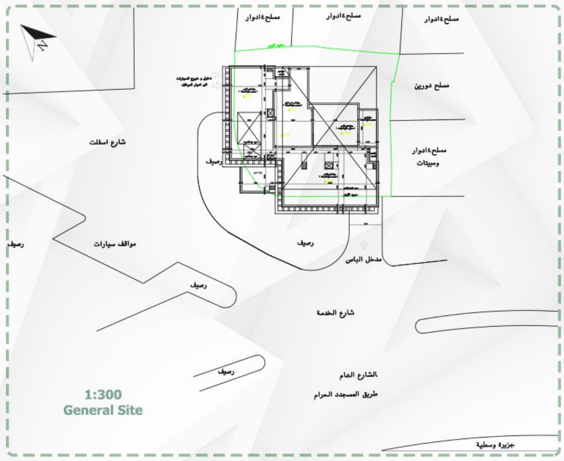


1:150
First Floor

Elevators 🟦
Corridors 🟧
Rooms 🟩

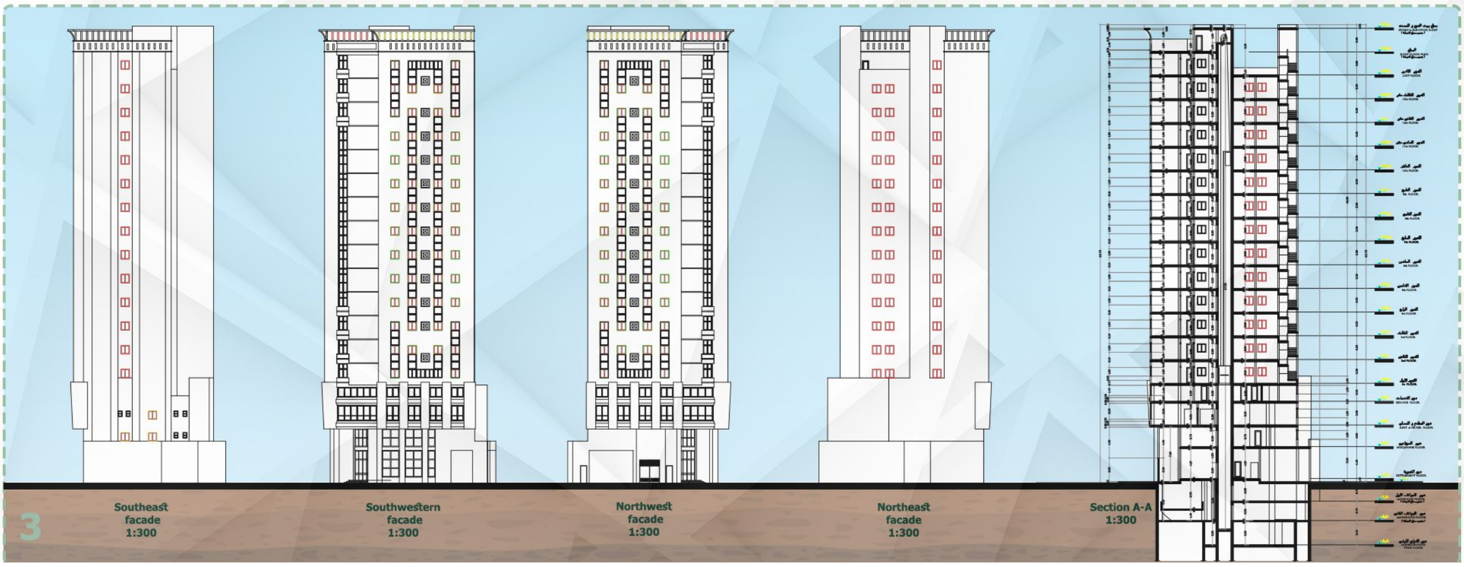
The designer relied on the design idea on distributing the hotel rooms on a corridor and making the main entrance on the west side and the car entrance on the north side of the building , which is the best part in the building in which the main entrance can be placed , Also, it is a design mistake to place service rooms and electricity rooms on the desired interface

General Site



1:300
General Site

Section & Facades



Southeast facade 1:300

Southwestern facade 1:300

Northwest facade 1:300

Northeast facade 1:300

Section A-A 1:300

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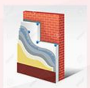
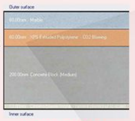
Current Situation

DesignBuilder SOFTWARE

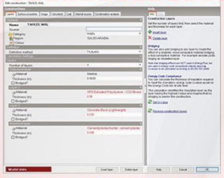
It is clear from the current situation that 657,257 KWH/Y energy is consumed
We seek to reduce this consumption through several proposals.



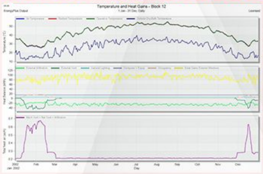
We use 4 layars : 60.00mm Marble
60.00mm insulator
200.00mm Concrete Block
13.00mm Plaster

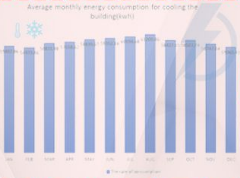


Section WALL



output





657257.00 KWH/Y

Annual energy consumption

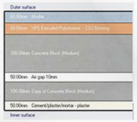
The Proposals

DesignBuilder SOFTWARE

1

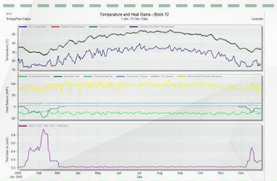
Three proposals to reduce energy consumption through walls will be proposed that can be used to save energy.

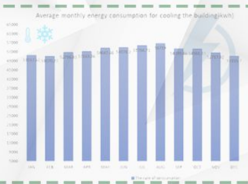
We use 6 layars : 60.00mm Marble
60.00mm insulator
200.00mm Concrete Block
50.00mm Air Gap
100.00mm Concrete Block
50.00mm Plaster



Section WALL

output





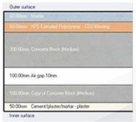
SAVE %6.87

612068.64 KWH/Y

Annual energy consumption

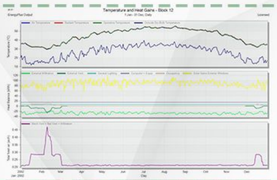
2

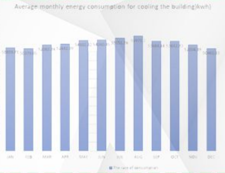
We use 6 layars : 60.00mm Marble
60.00mm insulator
200.00mm Concrete Block
100.00mm Air Gap
100.00mm Concrete Block
50.00mm Plaster



Section WALL

output





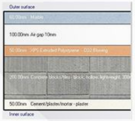
SAVE %8.11

603927.44 KWH/Y

Annual energy consumption

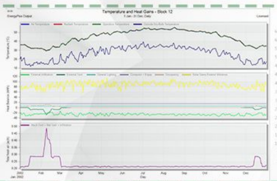
3

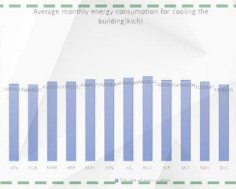
We use 5 layars : 60.00mm Marble
100.00mm Air Gap
50.00mm insulator
200.00mm Hollow Block
50.00mm Plaster



Section WALL

output





SAVE %25.95

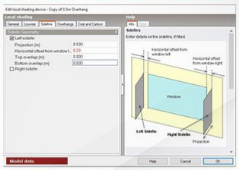
486656.80 KWH/Y

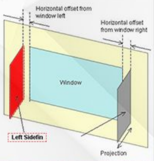
Annual energy consumption

1

Three proposals to reduce energy consumption through Solar breakers will be proposed that can be used to save energy.

We Use solar breakers on the Left side only :




Horizontal offset from window left
Horizontal offset from window right
Window
Left Sidefin
Projection

output

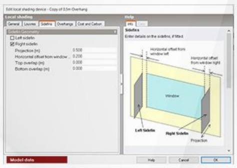
SAVE %5.92

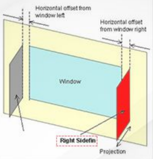
618333.85 KWH/Y

Annual energy consumption

2

We Use solar breakers on the Right side only :




Horizontal offset from window left
Horizontal offset from window right
Window
Right Sidefin
Projection

output

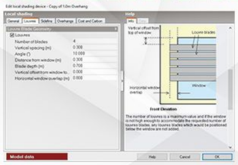
SAVE %3.36

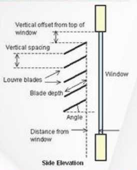
635121.56 KWH/Y

Annual energy consumption

3

We Use Horizontal Louvres :





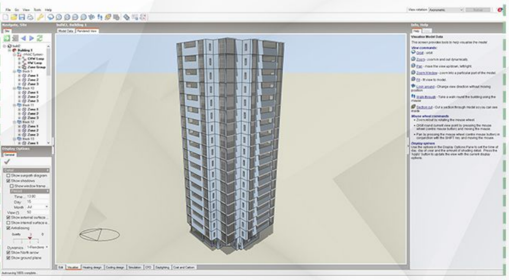
output

SAVE %5.92

618343.99 KWH/Y

Annual energy consumption

Definition



DesignBuilder SOFTWARE

DesignBuilder is an EnergyPlus based software tool used for energy, carbon, lighting and comfort measurement and control. DesignBuilder is developed to ease up the building simulation process. DesignBuilder is comparing alternative building designs by using function and performance-based method of comparison results by the various analyzes in a quick and economic manner.

DesignBuilder combines fast three-dimensional building modeling with dynamic energy simulations with its unique ease of use. Thanks to this feature it is regarded as a unique software tool to create and evaluate building designs. It has specially developed modules in order to be used effectively at any stage of the design process Only a few parameters to provide a wide range of opportunity to work up to the more detailed design of the particular design. DesignBuilder is easy to use. Its innovative productivity features allow even complex buildings to be modelled rapidly by non-expert users.

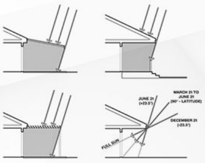
SUSTAINABLE DESIGN II
(MASTER)
REDESIGNING FOR HOTEL MAKKAH

by / Eng : Abdulaziz Aldelaiwi

Supervision
Prof.Khaled Samy
Prof.Ehab Rached

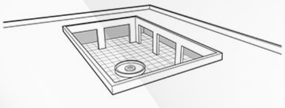
Design strategies

The outputs of the Mahoney schedule and climate advisory program we will put it her, the appropriate design strategies for the building, and we are working on developing it.



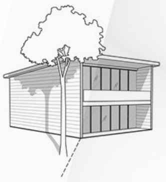
37

Window overhangs (designed for this latitude) or operable sunshades (awnings that extend in summer) can reduce or eliminate air conditioning



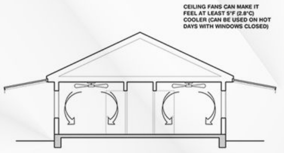
66

Traditional passive homes in hot windy dry climates used enclosed well shaded courtyards, with a small fountain to provide wind-protected microclimates



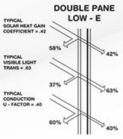
32

Minimize or eliminate west facing glazing to reduce summer and fall afternoon heat gain


CEILING FANS CAN MAKE IT FEEL AT LEAST 5°F (2.8°C) COOLER (CAN BE USED ON HOT DAYS WITH WINDOWS CLOSED)

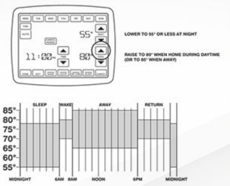
42

On hot days ceiling fans or indoor air motion can make it seem cooler by 5 degrees F (2.8C) or more, thus less air conditioning is needed


DOUBLE PANE LOW - E
TYPICAL SOLAR HEAT GAIN COEFFICIENT = .42
58%
42%
TYPICAL VISIBLE LIGHT TRANS = .63
37%
63%
TYPICAL CONDUCTION U - FACTOR = .40
60%
40%

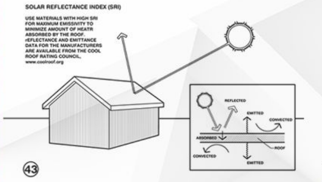
30

High performance glazing on all orientations should prove cost effective (Low-E, insulated frames) in hot clear summers or dark overcast winters



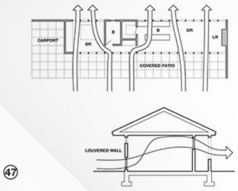
38

Raise the indoor comfort thermostat setpoint to reduce air conditioning energy consumption (especially if occupants wear seasonally appropriate clothing)


SOLAR REFLECTANCE INDEX (SRI)
USE MATERIALS WITH HIGH SRI FOR MAXIMUM EMISSIVITY TO MINIMIZE AMOUNT OF HEATR ABSORBED BY THE ROOF. rEFLECTANCE AND EMITTANCE DATA FOR THE MANUFACTURERS ARE AVAILABLE FROM THE COOL ROOF RATING COUNCIL, www.coolroof.org
REFLECTED
EMITTED
CONVECTED
ABSORBED
ROOF
CONVECTED
EMITTED

43

Use light colored building materials and cool roofs (with high emissivity) to minimize conducted heat gain

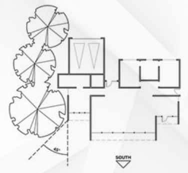


47

Use open plan interiors to promote natural cross ventilation, or use louvered doors, or instead use jump ducts if privacy is required

45

Flat roofs work well in hot dry climates (especially if light colored)



17

Use plant materials (bushes, trees, ivy-covered walls) especially on the west to minimize heat gain (if summer rains support native plant growth)

Strategies in Redesign

LOCATION & TRANSPORTATION

Intent

To reduce pollution and land development effects from transportation.

Requirements

Conduct a transportation survey of building occupants on their commute patterns.

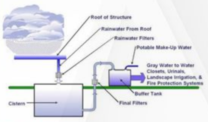
Regular building occupants must be surveyed. Building occupants shall provide information on their two-way commutes over one work week and consider seasonal variations and variations in work schedules. Visitors are encouraged to be surveyed, especially if the daily average is greater than the number of regular building occupants. Visitors shall provide information on their one-way travel to the building for that day in particular.

Conduct the survey at least once per year and calculate a transportation performance score for the project. **Proposals:**

SUSTAINABLE SITES

many technologies can be used on site :

Open-grid paving

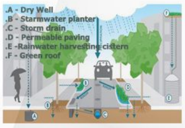


Rain tank

Detention pond

Green Roofs

Bioswales



Green Infrastructure

External finishes with good reflection coefficient

No Light Trespass

WATER EFFICIENCY

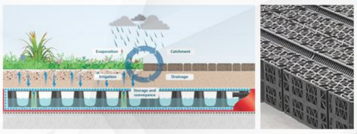
Intent

To support water management and reduce water consumption.

Requirements

Have permanently installed water meters that measure the total potable water use for the project and associated grounds. All potable or reclaimed water supplied to the project must be metered.

Proposals: Water use should be reduced by 20%



Polypipe Capillary Irrigation technology

Low-flow faucets

High-efficiency toilets
Dual Flush Toilet

Low-flow shower heads

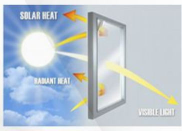
ENERGY & ATMOSPHERE

many technologies can be used:

water-cooled chiller

Renewable energy

Shading devices



Solar Control Glass

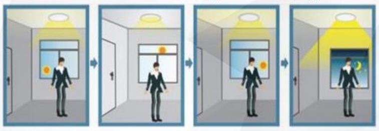
Double skin

Insulation

high-efficiency appliances

Efficient Lighting

Occupancy sensor



Daylight Sensor

Shading controls

MATERIAL & RESOURCES

Intent

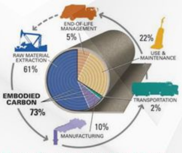
To reduce the environmental harm from materials and products purchased and used during operations and maintenance of buildings.

Paper products and empty paper containers
Empty plastic containers, Styrofoam, plastic material and metals
Food waste and paper napkins
Bottles and aluminium cans
Non-recyclable waste and mixed materials

Waste management

PVC found in: Piping
Lead found in: Historic Paint
Mercury found in: Compact Fluorescent Light Bulbs
CFCs found in: Refrigerants
Arsenic found in: Pressure Treated Lumber
Polyurethane found in: Sealants
CAULK

Examples of materials that may NOT be used



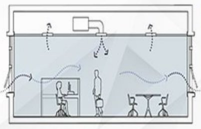
Use of materials that have information on the life cycle of the

INDOOR ENVIRONMENTAL QUALITY

Intent

To contribute to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality

No smoking inside the building



Mixes Mode
Mechanical & Natural

Designated smoking areas

Entryway Systems

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Mahoney Table

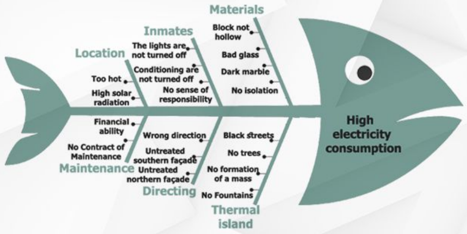
MSH	Top	2020-2015												
		12	11	10	9	8	7	6	5	4	3	2	1	Months
32	49	34	36	41	44	44	46	49	47	43	38	33	33	Bone temperature
34	15	17	20	20	23	24	23	21	22	20	17	15	16	Minimum temperature
													25/21 nort	Meridians
													49/39 east	latitudes
													300	Sea level rise
		Humidity												
		95	95	89	84	83	86	65	74	83	85	91	92	Average monthly maximum humidity
		27	22	10	10	11	10	8	10	12	15	13	19	Average monthly minimum humidity
		61	58.5	49.5	47	47	48	36.5	42	47.5	50	52	55.5	The overall average
		3	3	2	2	2	2	2	2	2	3	3	3	Moisture group
		3.6	3.9	1.9	2.3	1.6	0.2	0	0.7	1.9	2	0.9	4.1	Rainfall rate
		Wind												
		12	11	10	9	8	7	6	5	4	3	2	1	Months
		G	G	CG	G	G	G	G	T	G	G	G	G	Prevailing
		GCC	GCC	GCG	GCG	CG	TG	G	TT	GCG	GCG	GCG	GCG	Side
	Diagnostic table and conclusions													
	MHB	12	11	10	9	8	7	6	5	4	3	2	1	Temperature diagnostics
	32	34	36	41	44	44	46	49	47	43	38	33	33	Average monthly heat
		29	29	31	31	31	31	31	31	31	29	29	29	omfort during the day is an upper limi
		23	23	25	25	25	25	25	25	25	23	23	23	minimum
		17	20	20	23	24	23	21	22	20	17	15	16	Monthly mean minimum temperature
		23	23	24	24	24	24	24	24	24	23	23	23	omfort during the day is an upper limi
		17	17	17	17	17	17	17	17	17	17	17	17	minimum
		B	M	H	H	H	H	H	H	H	M	B	B	Heat jihad during the day
		B	H	H	H	H	H	H	H	H	M	B	B	night
	The signs													
														Wet R 1
														R. 2
														R. 3
	12	•	•	•	•	•	•	•	•	•	•	•	•	Dry C 1
	5				•	•	•	•	•	•				C 2
	3	•										•	•	C 3
					Total sum of indicators from the diagnostic table and conclusions									
						C3	C2	C1	R3	R2	R1	Category	sequence	
						3	5	12	0	0	0			
														Building condition
								من 0-10					1	outh orientation (longitudinal axis east
						من 12-5.		11،12						
						من 0-4						•	2	Collective planning
														Air movement
											من 12-1		3	The rooms are stacked in a row to
								من 0-5			1،2			
								من 6-12				•	4	The rooms are stacked in two rows,
										2،12	0			
										0،1			5	No air movement is required
														Openings
						0		1،0					6	Wide openings 40-80%
						1،0		12،11				•	7	Tiny holes 10-20%
									Any other circumstances				8	Medium openings 20-40%
														Walls
								0-2					9	Light walls lag a short time
								من 12-3				•	10	Heavy internal and external walls
														Surfaces
								من 5-0					11	Mild and isolated
								من 12-6				•	12	eavy roofs - more than 8 hours lag tim

Through Mahoney's Schedule and Climate consultant we will come up with design strategies and solutions that help us solve design problems in the building to achieve the principles of sustainability and make the building more energy efficient and takes into account thermal comfort.

Building Problems

1	a lot of glass on the building	9	High electricity consumption
2	The colors of the marble are dark on the facades	10	Do not illuminate the internal corridors with natural lighting
3	Treat all interfaces in one way	11	No green in the public site
4	The absence of insulating layers in the walls	12	No using renewable energy
5	No water collection system	13	No taking advantage of the high solar radiation
6	Reflective glass should be used	14	Double glazing should be used
7	Facades are not shaded	15	Green roofs do not exist
8	Water bodies are not used		

Fish Bones



Solutions

1	Installing solar breakers	9	Using energy-saving devices
2	Use of light colors on the facades	10	Use of sky lighting and sky lighting and use middle core
3	Designing each interface to match it	11	Use of afforestation
4	The use of wall insulators	12	Using the energy of the Earth's interior and solar energy
5	Make water collection system	13	Use of solar panels
6	Use of insulated glass	14	Use Double glazing
7	Shading of facades	15	Use Green roofs do not exist
8	Putting fountains in the public site to cool the atmosphere		

Expected situation

Current Situation

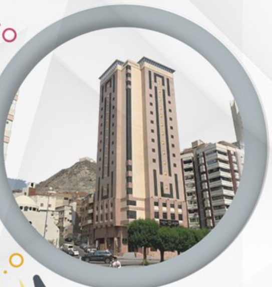
The southwest and northwest façades are not resolved from solar radiation

Dark marble brings heat to the building

Solid block

There is no heat insulation in the walls

Conditioning using Freon gas

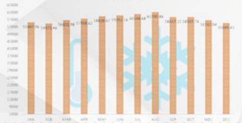


Total Annual electricity consumption

657257.00 KWH/Y

36.85 Loss

AVERAGE MONTHLY ENERGY CONSUMPTION FOR COOLING THE BUILDING



Proposed Situation

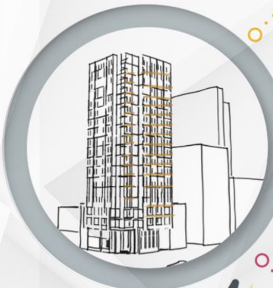
Using sunblocks on the building / Overhan 20cm Horizontal widow 30cm On the southwestern façade

Replace the dark marble with light colored marble to help reflect the solar radiation

Use hollow and isolated blocks

Using 5cm XPS Extruded Polystyrene

Conditioning using water chiller

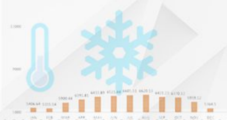


Total Annual electricity consumption

415023.21 KWH/Y

SAVE 36.85

AVERAGE MONTHLY ENERGY CONSUMPTION FOR COOLING THE BUILDING



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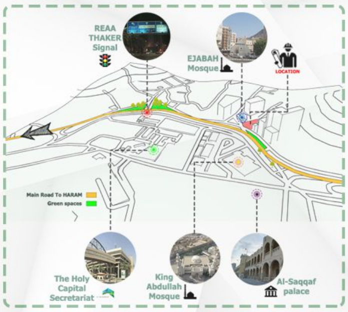
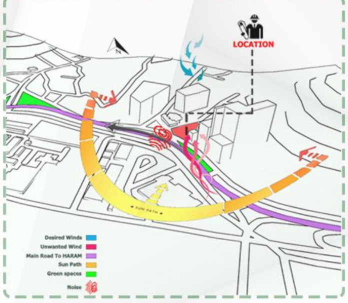
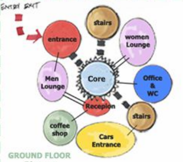
Site Analysis

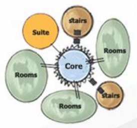




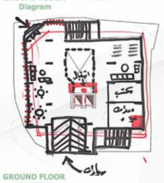
Sketchs



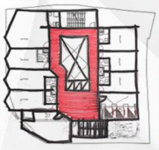
GROUND FLOOR Diagram



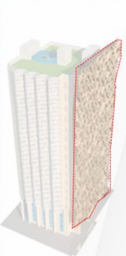
FIRST FLOOR Diagram



GROUND FLOOR SKETCH



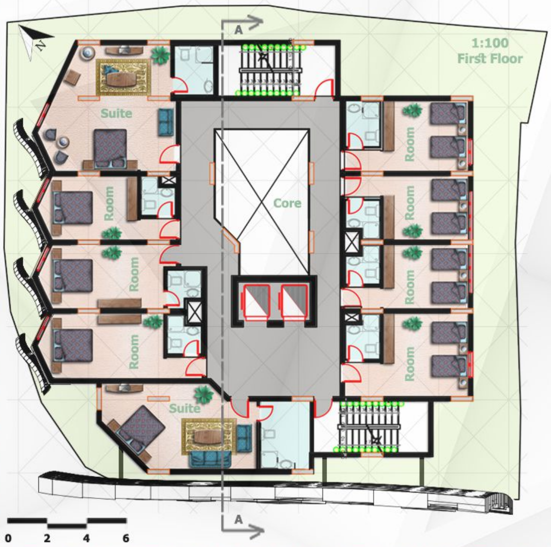
FIRST FLOOR SKETCH

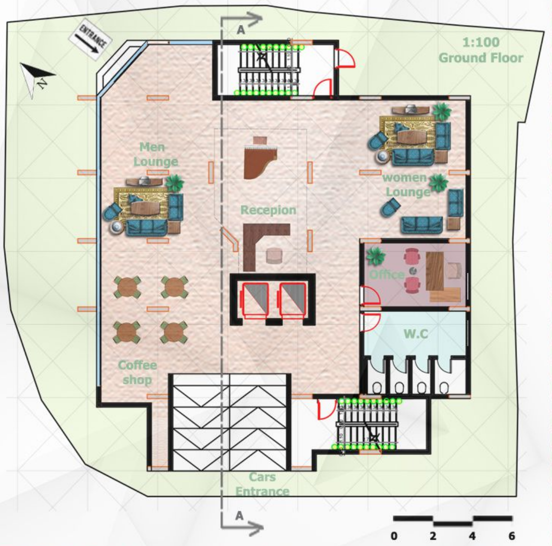


The southwestern façade was inspired by the Rawashen, which are considered one of the architectural symbols in Makkah Al-Mukarramah through which light and air can be entered without intense solar radiation , With no blocking of vision.

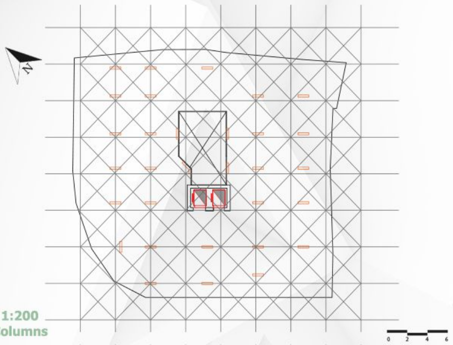
Plans To Redesign

The building will be redesigned to improve its performance and make it a sustainable and environmentally friendly building

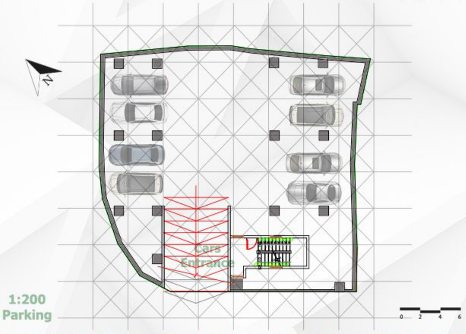




The building was redesigned, with rooms placed on a corridor with a core in the middle , The rooms were redirected to the north and the solar breakers were placed to avoid the southern sun , the escape stairs were placed in the southwestern facade and the elevators were in the center of the building.

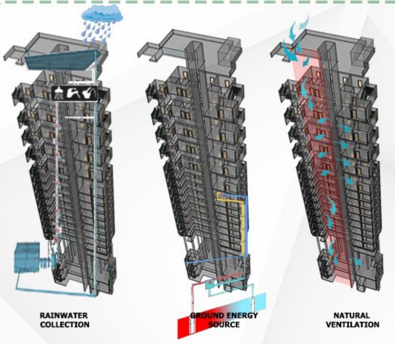


1:200 Columns



1:200 Parking

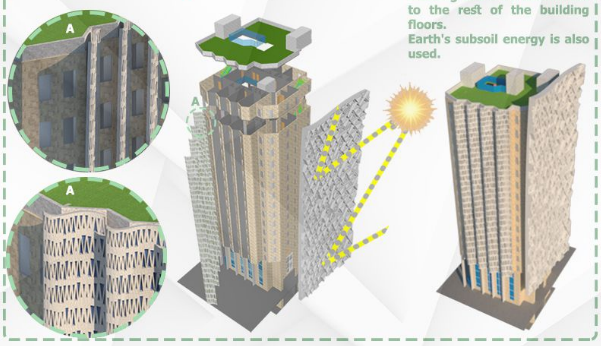
Building systems

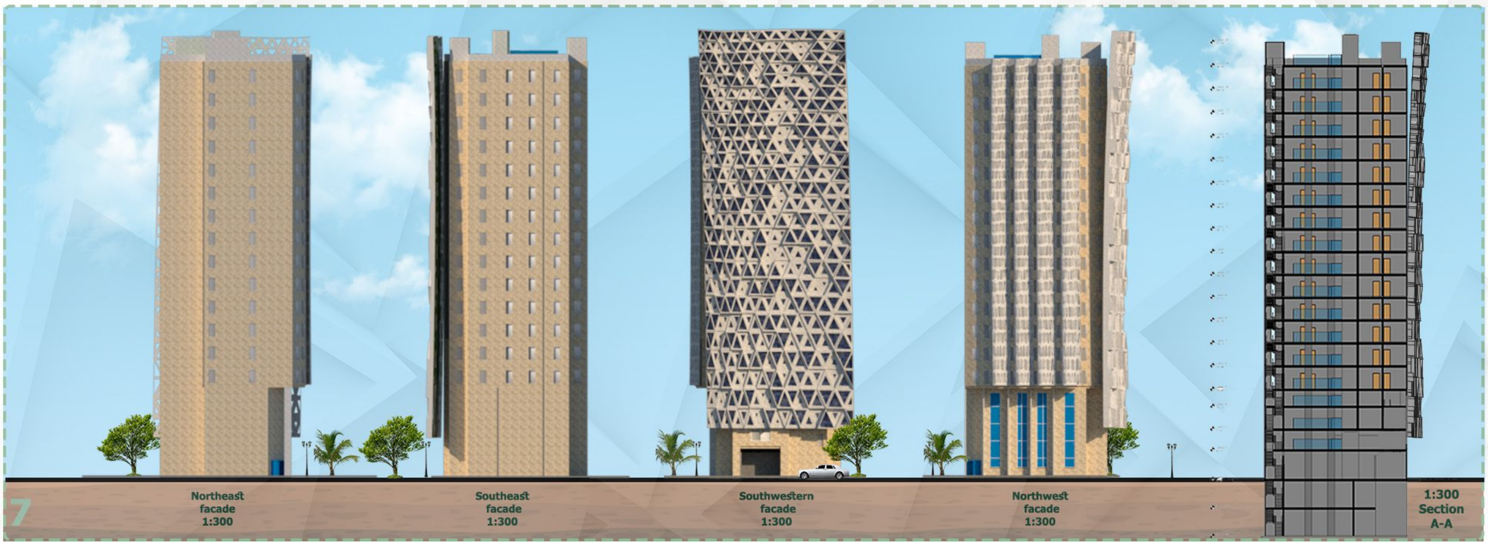


The building contains many systems that help the building's sustainability such as a rainwater collection system and an air movement system inside the building that helps to reach the building's thermal comfort and the green cover on the roof was used to reduce solar radiation with solar breakers on the southwestern facade.

As for the rainwater collection system, water is collected from the surface and stored in a tank in the ground for reuse , As for the air movement system inside the building, the desired air is brought in from the north side and entered into the building and then distributed to the rest of the building floors.

Earth's subsoil energy is also used.





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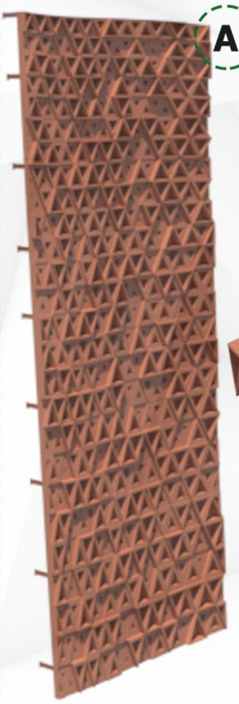
Facade Details

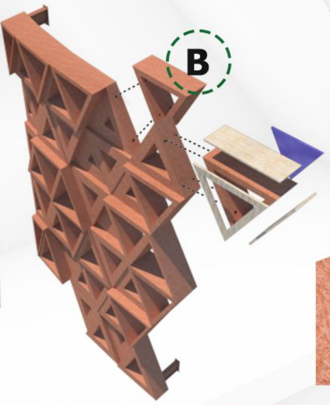


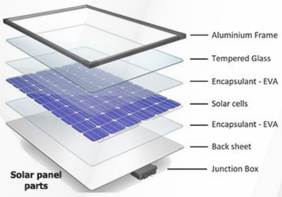
The GRC panels will be installed on a steel structure that will be installed on the building in the form of small triangles pieces fixed together with nails. After fixing the pieces together and installing them in the building, small solar panels are placed on the GRC in the façade in the projecting parts that are exposed to the sun and not shaded.

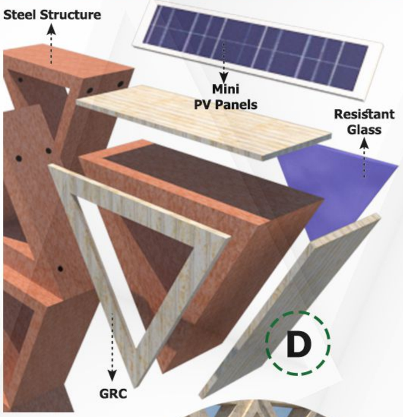
Making it more energy gain and thus storing the largest amount of solar energy that is utilized for the building and exporting the surplus to the public grid in an integrative process with energy gain through the heat of the earth's interior.

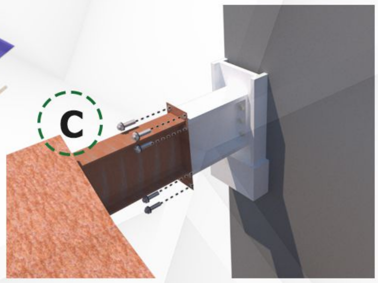
There are many similar examples of energy gaining through façades such as the Seoul office tower and Al Bahr tower in UAE .

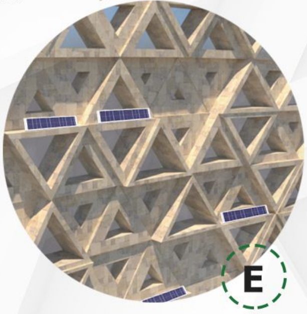
Clarification:
- A- Steel Structure
- B- Part of the Structure
- C- method of installing the steel structure in the building
- D- Dismantling the triangle
- E- View the locations of solar panels
- F- Final Steel Structure











Manufacturing method

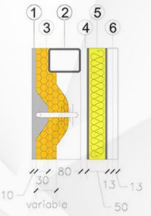
The Method Of Making The GRC :

To make GRC, you must first put a rubber mold and clean it well from all dirt in preparation for placing the first layer, and then add the glass fibers to the concrete for pouring the first layer, and then put the iron and pour the second layer , and then it is raised and installed on the building.

Mold cleaning

Glass fibers

Mix the glass fibers with concrete



LEGEND: 1- GRC sheet / 2- Metal tubular frame / 3- Insulation / 4- Air chamber / 5- Mineral wool between metal guides / 6- Double laminated gypsum board

Installation on the building

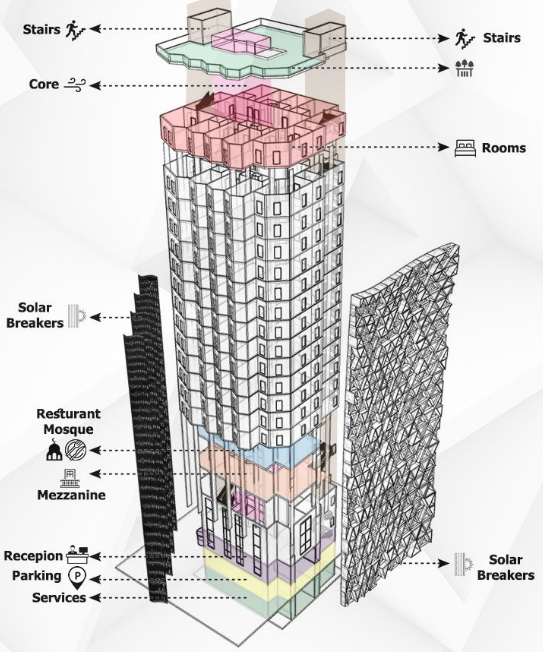
Apply the first layer

Steel mesh

Final form

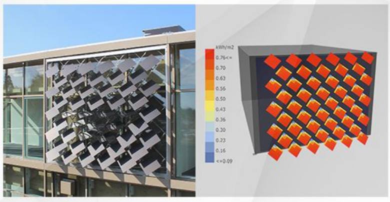
Steel frame to the GRC

Area Uses



Similar Examples

The Hanwha headquarters office tower in Seoul has been remodelled by Dutch architecture firm UNStudio, retrofitting its facade to hold solar panels.
UNStudio won the competition to retrofit the headquarters for the Hanwha Group – along with engineers Arup and landscape designer Loos van Vliet – in 2014.



Directing solar panels to an appropriate degree of solar radiation to maximize energy storage utilization

Programs Used

DesignBuilder SOFTWARE
AUTODESK REVIT
AUTODESK FORMIT
AUTODESK AUTOCAD
SketchUp
AUTODESK FLOW DESIGN
Rhinoceros
X
W
P
Ps
Ai